STRESS-TESTING EQUITY PORTFOLIOS FOR CLIMATE CHANGE IMPACTS: THE CARBON FACTOR

Understanding climate change policies

2015 marked the planet’s hottest year since temperatures were first recorded in 1880\(^1\). The temperature measurements align with the IPCC’s\(^2\) findings and climate model projections. In fact, according to the National Oceanic and Atmospheric Administration (NOAA), 2015, 2014 and 2010 have been the three hottest years on record.

It is with this backdrop that the ‘Paris Agreement’ from the Conference of Parties (COP) 21 produced a global climate change treaty under international law. The agreement states that global greenhouse gas emissions should peak ‘as soon as possible’ to keep global temperature increase to 1.5-2°C above pre-industrial levels. The temperature recorded for 2015 is already a 0.9°C increase.

While only some provisions of the Paris Agreement are legally binding, the political will to mitigate greenhouse gas emissions appears strong. National policy agendas and the Intended Nationally Determined Contributions (INDCs), particularly around energy and carbon footprints, are a signal of that commitment. They also provide a focal point that allows institutional investors to assess whether regulatory change might pose performance risks for their equity portfolios and the benchmarks chosen to measure their strategic asset allocation.

Institutional investors still continue to allocate a significant proportion of their economic capital to equity strategies, with the average global pension fund allocation to equities at over 42\(^\circ\), and key pension markets such as Australia, the United Kingdom and the United States of America with even higher allocations still. As such the risks to equity portfolios from climate change warrant closer attention, given the drivers of risk and of return to global pension schemes are intrinsically linked to equity portfolios.

Above all, many pension funds and other asset owners are extremely concerned about climate change and are committing to, or planning to, completely de-carbonise their investment portfolios.

Looking at the financial aspect, particularly for equity investors such as pension funds, understanding the risks of reduction in shareholder value and returns from climate change to their investment portfolios is critical, as it can have deleterious effects on their ability to meet liability streams. Reporting on transition risks (financial risks associated with the transition to a low-carbon economy) is one of the key requirements incorporated in Article 173 of the French Energy Transition Law, which can be supported using stress testing and scenario analysis. It is envisaged that these approaches can lead to further transparency on these risks, and assist the asset owner in their compliance with this law.

In 2016, BNP Paribas worked with Avalerion Capital to develop a new climate change stress-testing approach. Moving beyond assessing absolute carbon emissions as the principal risk factor our approach considers three mitigation-related policy factors and their impact on profit before tax (PBT): 1) carbon pricing; 2) energy efficiency policies; 3) energy subsidy policies.

At the heart of our stress-testing work are three fundamental questions:

- Does climate change policy pose material risks to the expected future performance of equity portfolios? And if so, which of the above factors are most significant?
- At what tracking error and performance ‘costs’ can equity portfolios be re-balanced, without any material loss of performance, to mitigate these risks?
- How can institutional investors build ‘better’ betas to mitigate losses driven by climate change risks?

We initially focused on carbon pricing as a key policy lever to measure the impact on PBT. The impact on fossil fuel reserves (stranded assets) and the results from stress-testing energy and subsidy policy factors will be presented in a subsequent publication.

\(^1\) National Oceanic and Atmospheric Administration (NOAA) – State of Climate Reports Year 2015
\(^2\) IPCC is the Intergovernmental Panel on Climate Change
\(^3\) The Investment Association Annual Survey Asset Management in the UK 2014-2015
PBT serves as a proxy for firm value, as the sum of future profits is correlated with the market value of each company. As such, a % reduction of annualised PBT serves as a proxy for the potential %-loss of market and stock value.

The carbon factor

Carbon pricing is increasingly used to influence emission behavior. Programs currently in play span 40 countries and regions and over 20 cities. They range from carbon taxes of US$ 50–130/ton CO₂ in some Scandinavian countries to Japan’s carbon tax of US$ 2–3, and cap-and-trade schemes that create emission certificates per ton of CO₂, capping the allowable greenhouse gas emissions in the relevant jurisdiction.

Global carbon pricing regimes

![Global carbon pricing regimes map](image)


The diversity of carbon price regimes highlights a patchwork of regulatory effort, which often competes at regional, national and city levels. Cap-and-trade schemes in different countries focus on different sectors. Emission certificates across markets are not easily tradable, given the underlying national regulatory complexities. Challenges in measuring, verifying and reporting the actual greenhouse gas emissions of each company add to this complexity. In sum, there is no globally agreed price for carbon emissions.

The carbon price signals from the largest cap-and-trade markets have also been weak. Price levels in the EU-ETS, the world’s largest cap-and-trade scheme, have hovered around the US$8-12 mark for a long time. China is migrating from piloting seven cap-and-trade regional markets to launching the world’s largest national carbon market in 2017. Carbon prices across China’s pilot regions vary, but are typically also in the US$8-10 range. Similar price ranges are evident across carbon markets in US, Korea and India.

These carbon price levels are in stark contrast to the ‘true economic cost’ of carbon, which, depending on the specific study, are estimated around US$65-US$85 per tonne of CO₂e. They are also significantly below the long-term coal-to-gas switch price point, which is estimated at around US$ 25-35.

The concept of using natural gas as a ‘transitional energy’ source has received endorsement by major oil and gas companies. It would require an alignment of energy policy across major economies to foster related infrastructure investments. Clear signals around carbon prices in the above mentioned price range would support this transition.

Our impact thesis and stress-testing approach

Given these carbon market and price ‘realities’, our thesis is that carbon is currently an underpriced risk for companies. It therefore poses a material and hitherto ‘hidden’ risk for institutional investors managing equity portfolios, which even nascent absolute carbon emissions analysis doesn’t assess.

It is important to note, that our stress-test includes a ‘PBT-impact’ approach, which markedly differs from optimising around absolute carbon emissions, for a number of reasons. It should also be noted that this report only takes into consideration emissions which fall under Scope 1 and Scope 2 of the Greenhouse Gas (GHG) Protocol. This includes all direct greenhouse gas emissions and all those produced from the consumption of purchased electricity, heat or steam. This report does not take into consideration emissions which fall under Scope 3 of the GHG Protocol. Indeed, Scope 3 can be very material in certain sectors and should theoretically be taken into account. However, there are still some practical concerns around Scope 3 data quality and availability at company level which prevented us from using it.

First, we attempt to translate the carbon profile of a company into the actual impact on its PBT, thereby creating an explicit link to financial performance. This is all the more critical to be able to support institutional investors’ risk assessments, and add to their holistic risk management frameworks.

Second, we adopt a forward looking view of carbon and carbon prices, projecting both emissions and creating price scenarios to 2025. Taking the MSCI All Countries World Index (ACWI) as a benchmark portfolio, we adopted the following six-step approach:

Carbon price impact stress-testing approach

![Carbon price impact stress-testing approach diagram](image)

Source: BNP Paribas & Avalerion
1) Macro-economic climate change scenarios:
   a) Business-as-usual (BAU)/Baseline scenario: 3-4°C warming trajectory
   b) INDC/Moderate scenario: 2.7°C warming trajectory
   c) COP 21/Aggressive scenario: 1.5°-2°C warming trajectory

2) Carbon price: we developed respectively three national carbon price scenarios out to 2025 for each of 6 core carbon markets\(^4\), accounting for – 75% of global GDP;

3) Carbon footprint at risk: We gathered the carbon footprint of all companies in the index using the Thomson Reuters Asset4 database, projected their carbon footprint out to 2025 and estimated how much of this footprint stems from markets that result in generating a cost factor to a company’s P&L;

4) Carbon cost pass-through: as a starting point to define a baseline, we assumed at a sector-level what percentage of projected carbon costs would likely need to be absorbed by the company and what percentage could be rolled-over onto the price of its goods and services. These estimates are based on our research and understanding about market power and demand price elasticity across sectors; for example we assumed that 100% of carbon costs in the utilities sector would get absorbed as incremental costs by the companies, while in the technology sector 50% of carbon costs could be passed onto the price of final goods\(^5\).

5) Portfolio loss: We calculated the carbon price impact on the PBT for 95%\(^6\) of companies in the MSCI ACWI using the above inputs.

6) Loss reduction techniques:
   a) Strategic asset allocation: determining which sector/country should be over-weighted or under-weighted?
   b) Smart beta using optimisation based techniques
      - The low carbon method seeks to optimise the portfolio of assets to minimise the absolute carbon footprint, under the constraints of tracking error and country and sector weightings.
      - The PBT hedged method seeks to optimise the portfolio of assets by minimising the impact of fluctuation in the price of carbon, under the constraints of tracking error and country and sector weightings.
      - The Smart Carbon Hybrid method seeks to combine both of the above methods, by first using the low carbon method to define a universe of assets comprised essentially of companies with small carbon footprints and then uses the PBT hedge to eliminate any remaining carbon price exposure to a portfolio of assets, under the constraints of tracking error and country and sector weightings.

With regards to the second step in our approach, we developed a view on carbon prices out to 2025 based on three scenarios for each of the six carbon markets that were within scope for our assessment.

We defined the BAU baseline scenarios as one in which the current patchwork of regimes will continue and grounded the forward-looking views for each market in an assessment of the key carbon price drivers. In each carbon market we performed a bottom-up assessment of key carbon price drivers, including projected economic growth, CO₂ emission levels and targets, current allowances and carbon tax situations, carbon market or tax policy reform plans (e.g. possible impacts of EU-ETS Market Stability Reserve) and other greenhouse gas mitigation policies such as renewable energy targets etc. We further assumed that the pricing dynamics in each market will continue to be driven by national policy agendas without significant linkages between markets.

Assessment of carbon price drivers in each market

On the basis of this analysis, we postulate future plausible carbon price levels for this BAU scenario of US$ 7-18 across the markets (excluding Japan).

Our moderate (or INDC) carbon price scenario assumes a more aggressive price level between US$ 20-35 in 2025, driven by the political will to accelerate the long-term coal-to-gas switch and establish linkages between major carbon markets.

We derived our third (COP 21 aggressive target) scenario by asking the question: “What would need to be true for carbon prices to deviate significantly from the baseline and moderate scenarios until 2025?”. We concluded that the most plausible possibility would be

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\(^4\) INDCs are the Intended Nationally Determined Contributions to reduce greenhouse gas emissions

\(^5\) COP is a Conference of the Parties as the governing body to an international convention; here United Nations Framework Convention on Climate Change (UNFCCC)

\(^6\) Carbon markets in scope: EU-ETS, China, Rep. of Korea, Japan, India and US

\(^7\) Thomson Reuters Asset4 database coverage
that in addition to the political will to limit warming to the 1.5°-2°C level, extreme physical climate impacts put pressure on policy makers in major economies to send strong carbon pricing signals that accelerate the de-carbonisation of the global economy. In this (least likely, but not implausible) scenario our assumed carbon price range via a tax is US$ 50–75 by 2025, within the estimated range for the true economic costs of carbon.

Relative sector impact on PBT by sector 2020

<table>
<thead>
<tr>
<th>Sector</th>
<th>PBT Impact</th>
<th>Baseline</th>
<th>Aggressive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilities</td>
<td>-15.3%</td>
<td>-35.5%</td>
<td>-76.5%</td>
</tr>
<tr>
<td>Basic Materials</td>
<td>-4.2%</td>
<td>-22.8%</td>
<td>-11.6%</td>
</tr>
<tr>
<td>Energy</td>
<td>-19.4%</td>
<td>-1.5%</td>
<td>-7.2%</td>
</tr>
<tr>
<td>Industrials</td>
<td>-2.8%</td>
<td></td>
<td></td>
</tr>
</tbody>
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Source: BNP Paribas & Avalerion

For the final step in our approach (Step 6), we re-balanced the benchmark portfolio using 'minimisation of total PBT impact in the portfolio' as the optimisation criteria, under a set of constraints and performed a three-year back-testing of our new portfolio:

i. Keep sector and country-weights +/-0.25% of the original index
ii. Allow maximum tracking error of 2%
iii. We compared our back-tested results with the results of re-balancing the portfolio using the absolute carbon emission reduction as the optimisation function.

Our findings

Carbon price stress testing and strategic asset allocation impact:

Under these carbon price scenarios and other assumptions outlined above, the P&L impacts on the companies by 2020 and 2025 are material in four sectors: utilities, basic materials, energy and industrials. The estimated annual PBT impacts in the benchmark portfolio under the baseline scenario range from 1.5% of PBT to 15% (2020) and 2% to 20% of PBT (2025). Under the aggressive carbon-pricing scenario, these impacts increase by a factor of 5, material under any analysis. This is a notional concept – because in reality, if a company’s PBT were to be subject to such annual impact, it would cease to be a viable operating entity well before such a profit degradation would be realised: the portfolio impact is therefore potentially 100% loss of the exposure.

Smart beta method analysed

Low carbon method

Using the low carbon method to minimise the absolute carbon footprint, under the constraints of tracking error and country and sector weightings, we created a low carbon portfolio with a low tracking error of 1.1% pa and with a higher annualised portfolio return of 14.9% pa (Sharpe ratio: 98.6%). This method reduces the carbon emission of the portfolio by more than 60%. However it only buffers about 22% of the PBT potential loss derived from the stress test which indicates that reducing the carbon footprint of the portfolio does not necessarily reduce the carbon financial risk of the portfolio. Indeed, the assessment of carbon risk takes into account many more factors in addition to the carbon emissions (such as the country exposure of the company, the carbon cost pass-through, etc.).

PBT hedged method

Re-balancing the portfolio using the PBT hedged method to specifically hedge the risk of carbon price fluctuations (under the constraints of tracking error and country and sector weightings), buffers this PBT-loss stress by over 90% in the carbon price baseline scenario. The ‘costs’ for this rebalancing are a 2.3% pa tracking error. The annualised performance of this carbon smart portfolio is 13.8% pa (Sharpe ratio: 87.8%), in line with the original MSCI ACWI at 13.6% pa (Sharpe ratio: 91.8%).

Smart beta is an investment concept that combines characteristics of both passive and active investing. It seeks to capitalise on the benefits of portfolio diversification, thus reducing risk, while improving returns by delivering exposure to systematic investment factors.

9 PBT impacts in other sectors were below 1.5%–2% of annual PBT

10 Smart beta is an investment concept that combines characteristics of both passive and active investing. It seeks to capitalise on the benefits of portfolio diversification, thus reducing risk, while improving returns by delivering exposure to systematic investment factors.
and then de-carbonising, it has its limitations. Increased transparency focused on carbon footprinting, price impacts to benchmarks and to portfolios starts with while a first step in the process of mitigating carbon to their risk management frameworks. To equity strategies, and as they assess improvements investors given their continued material allocations a clear quantitative repercussion for institutional especially in four high emission sectors. This has a material performance risk to equity portfolios, Our initial results show that carbon price does pose Conclusions

The annual turnover for the PBT hedged portfolio is over 160%, which can be at odds with institutional investors’ typical long-term investment horizons and the standard annual review of their strategic asset allocation.

Smart Carbon Hybrid method

The PBT Hedged method excels at carbon price mitigation by producing a buffer of 90%+ of the portfolio PBT. While this method has clear benefits, it can be enhanced with additional factors, for example, by adding an absolute restriction on the overall carbon footprint of the portfolio.

The Smart Carbon Hybrid method takes the advantages of both methodologies to further buffer carbon risk. The first step is to use the low carbon method to define a universe of assets comprised essentially of companies with small carbon footprints and then uses the PBT hedge to hedge any remaining carbon price risk, while maintaining the constraints of tracking error and country and sector weightings.

The Smart Carbon Hybrid approach will help investment managers to construct a portfolio that will allow investors to reduce their carbon footprint and mitigate their carbon price risk. This gives investors the advantage of immediate carbon reduction and insurance against carbon price movements to help them transition into the low carbon economy.

Taking the Smart Carbon Hybrid Approach is potentially a stepping stone for institutional investors on the path to the full decarbonisation of their portfolios.

Stress-testing and rebalancing portfolios on the basis of expected profit-and-loss impact due to carbon prices, yields different, and in our view more robust results, than simply ‘de-carbonising’ portfolios using absolute emissions. Managing carbon risk by using absolute CO₂ emissions by companies does not buffer a portfolio against financial impacts from future carbon price increases.

Creating smart beta or carbon smart portfolios using the presented approach can be achieved without sacrificing annualised returns. The ‘costs’ are a tracking error of ~ 2%.

We believe our approach provides a useful step towards assessing the possible financial impacts of carbon prices on the bottom-line of companies. Going forward additional P&L and balance sheet relevant dynamics should be considered. While we focus purely on cost impacts, revenue enhancing effects from selling ‘low carbon technology’ to the market and balance sheet effects from investing into carbon mitigation technology to avoid carbon costs are not considered yet. Also, in cap-and-trade schemes the allocation of allowances could offer opportunities for low-footprint firms (relative to their peers in the same sector) to sell allocated extra credits.

We continue to refine and expand our stress-testing results; for example, as a next step we are assessing the energy efficiency factor, the subsidy policy factor and the impact on fossil fuel reserves, in an attempt to fully stress-test policy impact of climate change on equity portfolios and will report on our findings in a subsequent publication. We are also working to further develop the Smart Carbon Hybrid approach mentioned in this paper, with an aim to reduce both the carbon footprint and the carbon price risk in the portfolio.

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Source: BNP Paribas & Avalerion

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